Economic complexity and location of foreign firms in China

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ECONOMIC COMPLEXITY AND LOCATION OF FOREIGN FIRMS IN CHINA

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Abstract

This paper uses a unique dataset covering 1998 to 2007 to evaluate the impact of economic complexity on the location of foreign direct investment in China. Results show that the amount of knowledge embedded in an industry is a key determinant to attract FDI. The findings also confirm the presence of agglomeration economies and this effect is more likely for non chinese foreign firms. The results are robust to different alternatives in the location decision, different sub-sample, to the inclusion of control variables such as those for industry linkages and others traditional determinants of FDI attraction.

Keywords: Foreign Direct investment, China, Economic complexity, Conditional logit, Agglomeration

JEL: F1, F23, O14

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1. INTRODUCTION

Since the former speech of Deng Xiaoping in 1978, China has extraordinarily attracted billion dollar of foreign investment. Through those decades, the stock of Foreign Direct Investment from world major economies exceeds $760 billion. China became in 2009 the second largest recipient of offshore investment. (*World report Investment*, UNCTAD). Chinese government gives top priority to attract Foreign Direct Investment notably by enhancing the attractiveness of the territory through various policies. Multinational investments in China seek for profit maximization while this expected return depends much on the quality of the host location.

In recent years, literature on FDI focused on the role played by the human capital and institutional quality to explain attraction of FDI [1]. Major studies such as Cheng and Kwan (1999, 2000) used different proxies to capture the estimates of labor quality on FDI. Little evidences, however, show a dominant pattern concerning the human capital. One notable exception is Paloni et al (2001). They evaluated the hypothesis that quality of human capital can exerts a positive pressure on FDI. They found, indeed, that human capital played a significant role to entice FDI and this effect is gradual over time. Another study (Gao, 2002) used Chinese disaggregated provincial level data to assess the presence of skill labor as a substantial factor pulling FDI. Conversely to Cheng et al, this paper discovered that workers with better education are more trainable, and thus locations with better-educated workers are more likely to be preferred by FDI. But such studies do not assess precisely the knowledge of a choosing location.

Specifically, to conduct this study, estimation does not depend on formal variables to measure the impact of the host location's quality. Instead, this paper is built on an exclu-

[1] See, among others, Du and Tao (2008), Wei (2000a, 2000b), Campos and Kinoshita (2003)

sive index, so-called economic complexity (Haussmann and Hidalgo, (2009, 2011)), which better captures the knowledge embedded in a society. Economic complexity emphasizes not only the knowledge held individually but also how a society is able to coordinate knowledge in order to make complex product. Economic complexity does not rely on the stock of knowledge or what is taught at school rather on what a society makes with this knowledge. The ability of a country to perform certain tasks or products mainly depends on the amount of capabilities it holds and especially on the possibilities it can make with these capabilities. Therefore, the productive structure of a country reveals crucial information about the economic progress. Previous researches indicate that foreign firms hold more technological advancement that makes them sensitive to the local availability of knowledge (Xu et al (2009), Dunning (1993), Luo (1999), Wang et al (2002)). Naturally, this paper addresses the question to what extent the economic complexity entices foreign direct investment.

China is a particularly interesting country in which to study FDI inflows. Since the late 1970, China has gone through two fundamentals changes. On the one hand, China turns to be a more opened country, on the other hand, experienced a transition from a "command economy" to a market economy. Wei (2000) argues that economic transition in china implies a triple process of decentralization, globalization and marketization. The latters transformed the geographical concentration of China for two reasons. First, during the past decades, China has attracted billion of US dollar of foreign investment. Globalization, outlined by scholars (Fan et al (2003), Wen (2004)), re-enforced the agglomeration by increasing the uneven distribution of foreign investment. Some provinces received more than 10% of total FDI inflows whereas other central provinces obtained an amount close to 0. Second, marketization of the economy lead to a high concentration of manufacturing

activities and increased inter-firm linkages (He et al (2007)). By providing an assessment of the importance of complexity, this study can provide some guidance on the kind of policy instruments that can entice FDI in more disadvantaged provinces.

Recent studies on determinants of FDI in China were limited by the data collected by the China Bureau National of Statistic. Surveys conducted by the Chinese authorities were restraint to two-three years span[2], which makes difficult temporal comparison. Head and Ries (1996) is one notable exception because they proposed estimation based on 8 years period covering 54 cities. Nevertheless, China has dramatically changed over time and so legislation. Legal statue for foreign invested enterprises is not restricted to joint venture, as in Head and Ries. For instance, some researchers have examined the effects of ownership structure on the sensitivity to labor qualification (Luo (1995), Tao (2002)). Meanwhile, previous analysis in the field of FDI determinants have mainly focused in a cross-country study using bilateral aggregated FDI flow data, which make impossible to control for identity of foreign investors (Tuan (2006), Sun et al (2002), Coughlin et al (1999), Paloni et al (2001)). To overcome these issues this dissertation gathers data from over eight years collected at disaggregated level.

Finally, most studies take into account the stock of knowledge through education level, R&D and others determinants. Researchers, however, have not treated the product structure in much detail. This issue has grown importance in light of recent findings on the role of complexity[3]. Therefore, these study aims to contribute to this growing area of research by exploring the impact of presence of diversified knowledge on foreign direct investment.

The dataset used to test the impact of the diversified knowledge on FDI location covers

[2]Amiti and Javorcik (2008) : span 1998-2001

[3]Poncet (2013), Hausmann and Hildgo (2009, 2011), Rodrik, (2004)

a period of 1998 to 2007 made by 9.363 foreign investment enterprises. The model allows up to 174 cities and reveals that investments tend to be located around the coastal regions where some cities display high level of capabilities availability. The conditional logit estimation provides support that complexity is a subsequent factor to promote foreign investment. The results suggest that increasing the level of complexity in a sector by one percent is associated with a ten percent increase in entry of foreign firm. The analysis also confirms the presence of agglomeration economies with a stronger effect for non chinese foreign firms.

There is a large literature body describing the factors attracting FDI. Firm level analysis of FDI decision point out the relevance of typical market variables, including cost of capital, market size, labor cost or policies (Devereux and Griffith, 1998, Henderson and Kuncoro, 1996, Head et al, 1999). Precisely, Mayer et al (2010) showed a network effect on new FDI. Firms tend to set up new affiliates closed to others affiliates belonging to the same industrial group. Location choice in China is also well documented. Coughlin et al 1990, Broadman and Sun 1999, Cheng and Kwan 2000, Coughlin and Segev 2000 emphasized traditional FDI location determinants (Market size, wage, labor quality). The other strand of the literature stresses the importance of vertical investment. Amiti and Javorcik (2008) were among the first to take into account supply access as the most important factor to attract FDI in China.

The rest of the paper is organized in the following way. On the next section, data used and measurement variables are set out. Section 3 then presents the empirical approach, result and robustness checks. Last, Section 4 concludes

2. DATA AND MEASUREMENT

2.1. Data

The national bureau of statistic (NBS) conducted surveys from 1998 to 2007 on domestic and foreign firms with sells above 5 millions RMB. These surveys included only manufacturing sectors, therefore agriculture and others services companies were not listed. Basic information was asked such as output, export, employment, 4 digits Chinese Industry Classification and financial information. By focusing on Foreign-Invested Enterprise, all domestic firms and portfolio investment, defined as an acquisition of domestic capital less than 10% are excluded from the dataset. Furthermore, collected data that did not satisfy the requirement are also deleted, including negative output or export and firm with capital equals to 0.

After deleting all those firms, the dataset contains roughly 9,363 firms belonging to more than 400 industries. Table 1 lists the annual entry of foreign investment enterprises newly established by the year of registration. This table only exhibits the total new entry and not by city. Because this paper focuses on the complexity computed at the city level, column 4 displays the number of cities in which the complexity has been measured. The dependent variable is the location choice at the city level made by foreign invested enterprises. The number of choices is up to 174.

In appendix, a more precise table displays the highest entry of firm classified by type. However, one pattern of investment emerges from this chart. Foreign investment is mainly in textile production with a highest entry of 29, following by hemp textile and metal products.

Table 1: Entry of FDI into China by year

Year	FDI entry	Accumulated entry	Number of choice
1998	678	678	104
1999	443	1121	105
2000	340	1461	88
2001	522	1983	123
2002	447	2430	108
2003	792	3222	135
2004	2133	5355	174
2005	1190	6545	156
2006	1345	7890	131
2007	1473	9363	141

The database allows disaggregating FDI by type (figure 1). Hong Kong, Macao and Taiwan (HTM) are majors source of investment. As mention by Xu et al (2009), Investors from these Chinese islands can take advantage of their cultural affinity and the knowledge of the Chinese market. Over time, wholly owned type of ownership is preferred to the equity joint venture. This trend is similar for the others foreign invested country.

Figure 2 provides a breakdown of manufacturing FIE's by geography. The table distributes investment into three major locations, coastal, midland and western part of China. Quickly, this table shows an inward of FDI concentrated toward the coastal regions.

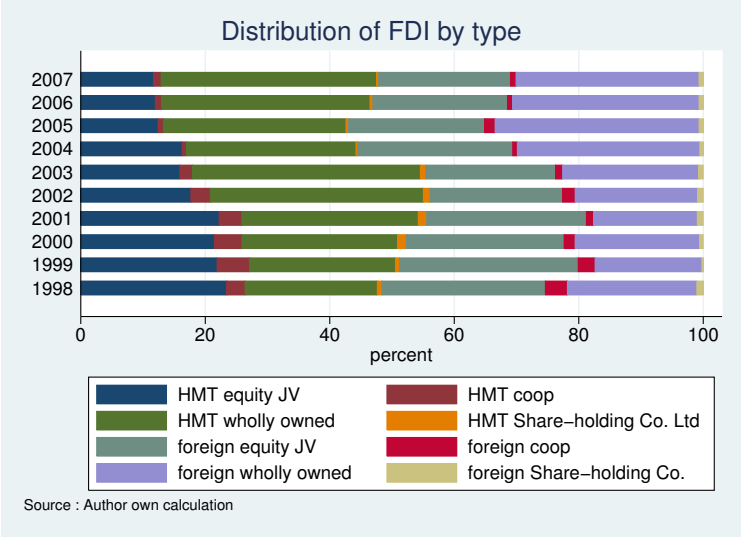

Figure 1: Firm distribution

For instance, in 2007, Guangdong province receives 33% of all the investment. Midland province and western province share very unequally distribution of FDI. Midland region perceived approximately 15% of FDI inward flow in 2006 against less than 10% for western part for the same year. Provinces like Ningxia, Yunnan, Shaanxi, Guangxi and Gansu were the less attractive in the selected sample.

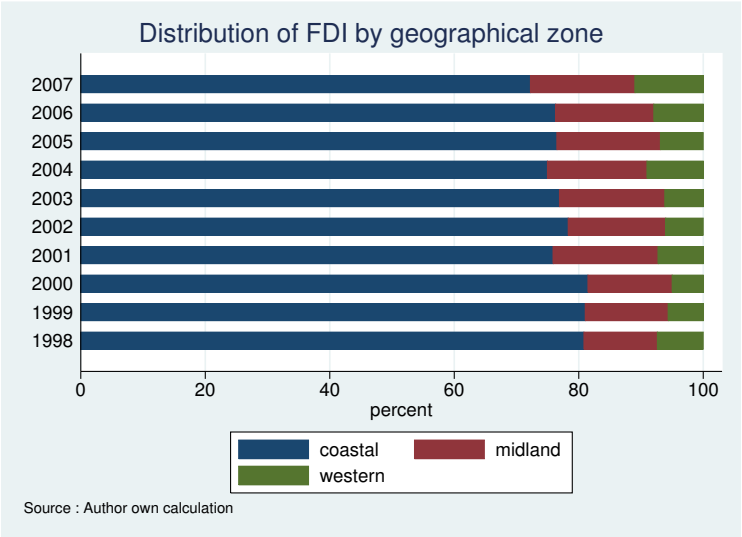

Figure 2: Geographical distribution

2.2. Variables

Indubitably, foreign investments improve the quality of the host country. China attracted limitless FDI since decades. In parallel, the product structure of China is perceived as being similar to rich countries (Rodrik, 2004). Estimate the impact of complexity as being a factor pulling FDI in China can help to explain this incommensurable production enhancement.

2.2.1. Economic complexity

Product complexity

Early literature focused on formal measures (R&D, schooling, infrastructure) to evaluate the knowledge of a society. However, this measure lacks of precision because it tells little about how a society manages its knowledge. Analogous, economic complexity starts by looking at what the country produces then deduces its stock of knowledge. This approach developed by Haussmann and Hidalgo (2009, 2011) emphasized the indirect availability of local capabilities. Indeed, countries are able to produce complex goods because their market is efficient enough to get together tacit knowledge of some individual and the needs of others individuals. Theory of capabilities connects the country's diversity and product's ubiquity to infer intrinsic features of both country and product. Consequently, countries that have an RCA in the same products share the same capabilities.

Ubiquitous informs on how many countries export with a RCA[4] product k and is computed as follow:

[4]Revealed comparative advantages developed by Balassa (1964) is the ratio of export share in the country's export basket for a given product to the same share at worldwide level:
$RCA_{jk} = \frac{x_{jk}/X_j}{\sum_j (x_{jk}/X_j)}$

$$Ubiquity_k = K_{k,0} = \sum_j M_{jk} \tag{1}$$

Diversification, however, aims to induce the specificity of a country. More precisely, it tells how much a country exports products with reveal comparative advantages.

$$Diversity_j = K_{j,0} = \sum_k M_{jk} \tag{2}$$

where j refers to the country, k to the product and M_{jk} is equal to one if country j exports product k with a RCA

Nevertheless, it is necessary to correct both measure to extract the authentic value of the complexity. Truly, country endows by a rare resource is regarded as being not ubiquitous but it does not make it necessarily diversified. Conversely, looking at the product line of a country only is misleading. A country exporting many products does not tell anything about the structure of the production. The method of reflection consists to remove the error of ubiquity using diversity and vice versa. Combining both information apprises on the complexity of a country. This method implies to combine the average of ubiquity using diversity. Then this value is used to extract the average of diversity and so on. In fact, the first iteration of diversification indicates how common are the products export by a country. By analogy, the first iteration of ubiquity designates how diversified are the countries exporting a given product. Finally, a country produces complex goods if the latters are less ubiquitous (possesses specific knowledge) and diversified (produced by few countries).

The product complexity is hence computed as follow, where n corresponds to the number of iteration:

$$K_{k,n} = \frac{1}{K_{k,0}} \sum_j M_{jk} K_{j,n-1} \tag{3}$$

$$K_{j,n-1} = \frac{1}{K_{j,0}} \sum_k M_{jk} K_{k,n-2} \tag{4}$$

This process is renewing until any information can be reveal about the availability of capabilities in a country. This method relies on international trade dataset[5] at the product level (6-digit). The dataset, composed by 5017 products and 230 countries, shows the product convergence at the 15th iteration. The measure is computed for the year 1997 because data were available and to avoid influence of time-varying error, the estimation will take only this year as a benchmark.

Complexity city sector

City-sector complexity, K_c^i indexing i as industry, is derivate following Hausmann and Hidalgo (2009):

$$K_c^i = \frac{1}{K_{c,0}} \sum_{k \in i} M_{c,k} K_{k,15} \tag{5}$$

City sector complexity is the sum of product's complexity $K_{k,15}$ exported with a RCA $M_{c,k}$ by industry divided by the count of the industry's RCA $K_{c,0}$. City RCA comes from the Chinese customs data over the 1997-2007 period, which release export information by 6-digit product. Finally, the measure of economic complexity requires to be standardized (Hausmann and Hidalgo, 2011) as follow:

[5]BACI word trade dataset provided by the Cepii

$$SectorComplexity_c^{ti} = \frac{K_c^{ti} - \sum_c K_c^{ti}/n}{\sigma K_c^{ti}} \tag{6}$$

Figure 1 plots a map where complexity at the city level[6] and the FDI count are displayed. A brief look at the map shows that the FDI count is located on the coastal regions (grey circles). The bigger circles indicate the cities with higher FDI inwards.

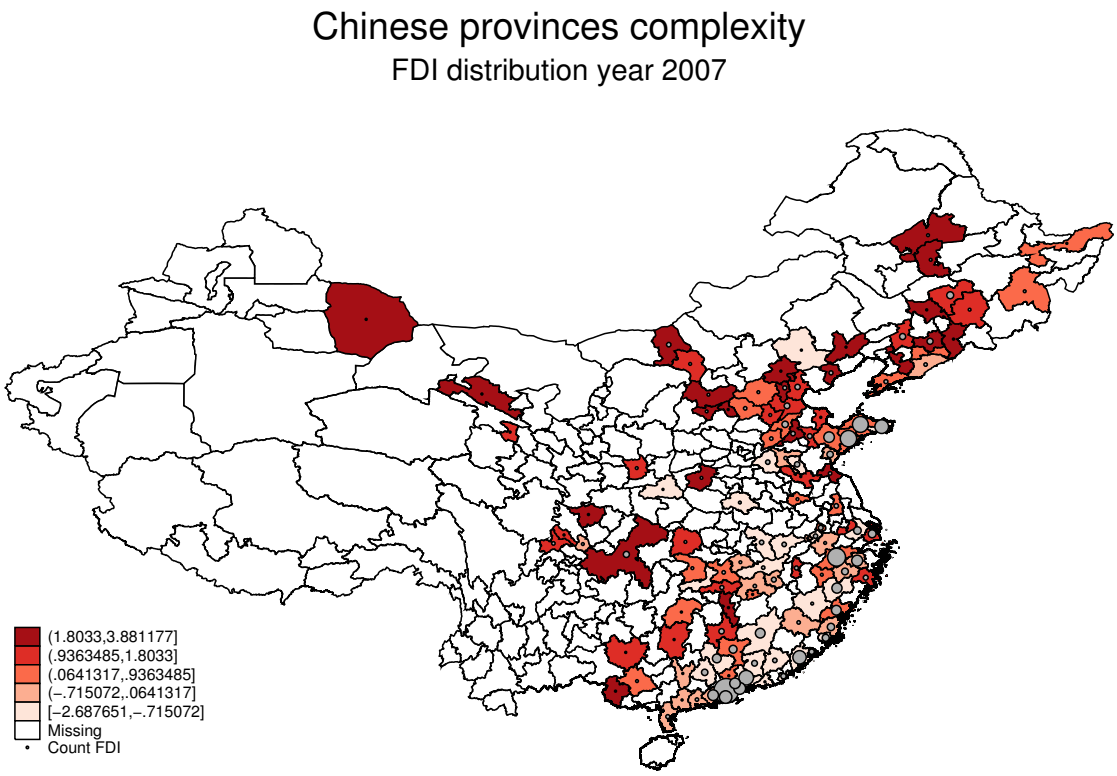

Figure 3: Map China

The map exhibits the economic complexity for 174 location choices as well. The darker

[6]computed as follow:

$K_c = \frac{1}{K_{c,0}} \sum_k M_{c,k} K_{k,15}$ and then standardized.

colors indicate higher levels of complexity while lighter colors show low levels. Regions like Shandong, Chongqing or Shanghai have both high level of complexity and attract foreign investment. Another pattern coming from the south tells region like Guangdong or Fujian, where special economic zone are widespread, entice foreign investments but with middle complexity index. A closer look at the data shows many foreign firms located in these areas are engaged in low-skilled required manufacturing (textile, workshop, etc.).

2.2.2. Other variables

Agglomeration effect proves to be an important factor in determining the location decision. As demonstrated, foreign firms are sensitive to underlying agglomeration forces. Marshallian's externalities, in this set up, have been widely documented in the literature[7] . For instance, concentration of activities appear extremely strong in China as highlighted Wei and He (2008). More precisely, globalized industries are clustered in the coastal regions. These clusters emerge in result to the availability of specialized labor, sharing of inputs and knowledge spillovers (Pugas et al (2004, Fujita and Thisse (2000)). In particular, increasing urban density enhances human capital and help firms to better match their needs (Rosenthal and Strange 2008).

New economy geography theories[8] (NEG) suppose firms can gain from urbanization with horizontal effect and vertical effect. On the one hand, firms tend to set up new plants in region where the size of the market is large. On the other hand, be near from many suppliers makes the market better quality, which in turn attracts more firms.

[7] See Fujita and Thisse (2000), Pugas et al (2004), Porter (1998), Rosenthal and Strange (2005)
[8] Krugman and Venables (1995), Venables (1996)

Agglomeration variables

Sectorial network is computed following Mayer et al (2010). This variable consists to count the number of firms in the same industry newly entered in a city from previous years.

$$SectoralNetwork^{i}_{c,t} = \sum_{u<t} \sum_{s} D^{i}_{sc,u} \tag{7}$$

where $D^{i}_{fc,u}$ is a dummy equal to 1 for all affiliates s of industry i located in city c and created in year u or before. The other agglomeration variables are based on the backward and forward linkages that exist between firms. Amiti and Jarvocik (2008) computed horizontal and vertical investments as follow :

$$SA^{i}_{c,t} = \frac{1}{\sum_{k=1}^{K} D_{ck}} \sum_{j=1}^{J} a_{ij} \phi^{j}_{c,t} \quad \text{where } \phi^{j}_{c,t} = \frac{Y^{J}_{c,t}}{Y^{j}_{CHINA,t}} \tag{8}$$

$$MA^{i}_{c,t} = \frac{1}{\sum_{k=1}^{K} D_{ck}} \left[\sum_{j=1}^{J} b_{ij} \phi^{j}_{c,t} + b_{i} \lambda_{c,t} \right] \quad \text{where } \lambda_{c,t} = \frac{GDP_{c,t}}{GDP_{CHINA,t}} \tag{9}$$

The coefficient a_{ij} comes from the China national input/output (I/O) table for 2007. Eq.(9) and (10) also consider the effect of distance by dividing supply and market access to billateral distance D_{ck}, where $c \neq k$.

Horizontal investment (market access) indicates that output of a firm can be an input for many others downstream industries or can be consumed as final good by consumers. In appendix, horizontal investment is plotted for the year 2007. An apparent positive relationship demonstrates that firms choose location close to large demand. Vertical investment (supply access), however, reflects the proximity with the upstream industries. Figure 4 provides an example for the textile manufacturing. Vertical investment is plotted

from the cumulated number of textile investment in different cities against the supply access of upstream industry –knitted and crocheted fabrics. The positive relationship is clear.

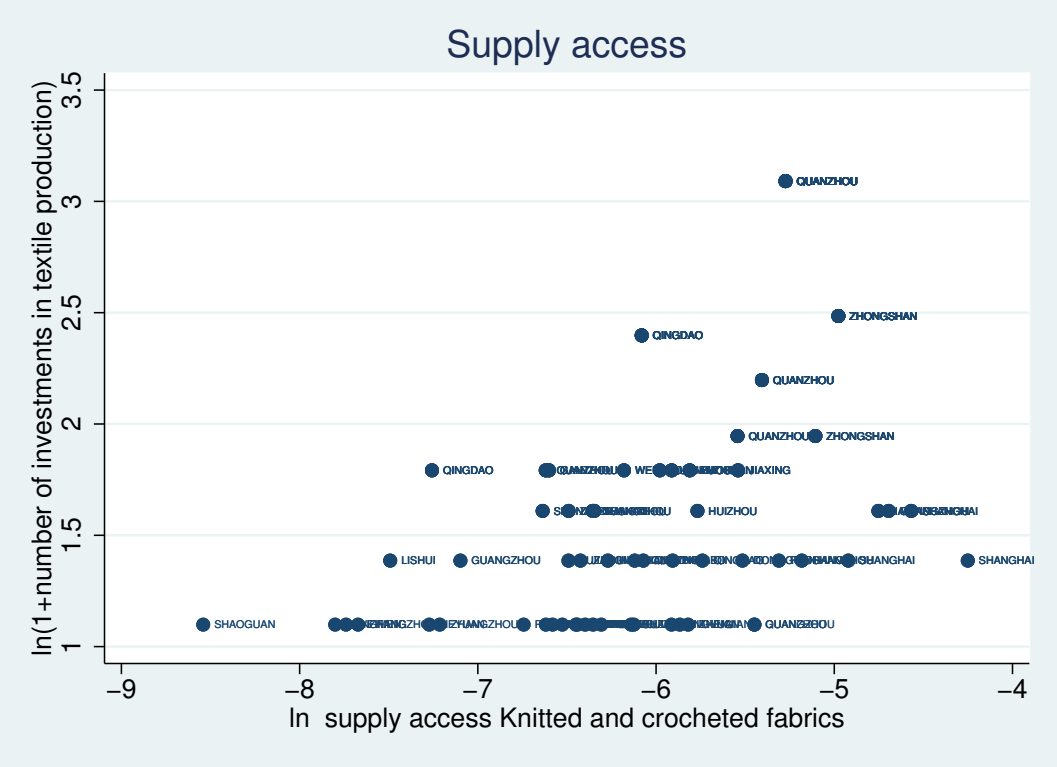

Figure 4: Supply access

Other commonly used control variables

In this specification, foreign market access is included to allow foreign firms to serve international market. This variable follows Mayer et al (2010), based on a gravity approach[9].

[9]Foreign market access is computed as follow :
$MAForeign_c = \sum_j \theta_{ij} E_j P_j^{\sigma-1}$ where θ_{ij} measure the freeness of trade and $E_j P_j^{\sigma-1}$ is the importer fixed effect. Databaset come from Cepii

3. EMPIRICAL STRATEGY AND RESULTS

3.1. Empirical strategy: conditional logit

Literature on location choice usually refers to conditional logit estimates. Suppose firms maximize their profit subject to cost minimization and uncertainty regarding the location choice. Firms will screen all possible location and build a plant where it is expected to have the higher profit. Attractiveness of a location is determined by observable characteristics and unobservable characteristics. The latter is eliminated by provincial fixed effect and captures characteristics that are common to all investors, independent of time of entry or the industry.

The model also includes a set of variables X_{ct}, representing observable characteristics of location c that vary across investors. The profit equation for a typical investor s in city c is:

$$\pi_{sct} = \theta + \beta X_{ct} + \varepsilon_{sct}$$

The probability of firm s to choose location c is :

$$\begin{aligned} P_s(c) &= Prob\left\{\pi_{sct} \geq \pi_{skt}\right\} \text{ for all } k \neq c \\ &= Prob\left\{\varepsilon_{skt} \leq \varepsilon_{sct} + \beta(X_{kt} - X_{ct})\right\} \text{ for all } k \neq c \end{aligned}$$

If the error term follows Type I extreme distribution, then the probability of choosing location c can be simplified to the following logit expression (MacFadden (1984)):

$$P_s(c) = \frac{\exp^{\beta X_{ct}}}{\sum_{k \in K} \exp^{\beta X_{kt}}} \tag{10}$$

Hence, the econometric equation yielded by city c to affiliate s is :

$$P(y = 1 \mid x) = \beta_0 + \beta_1 complexity.sector^{i}_{c,t} + \gamma Z_{c,t} + \eta_p + \mu_t + \varepsilon_{c,t} \tag{11}$$

where y denotes the firm location choice and c for the cities. Complexity for industry i proxies for the number and exclusivity of capabilities, as discussed in section 2.2.1. The rest of variables, $Z_{c,t}$, control for typical agglomeration effect and city specificities. The models also controls for provincial fixed effect η_p.

3.2. Results

3.2.1. Baseline specification

The major objective of this study is to investigate the role played by complexity in attracting FDI. There are up to 174 possible host cities chosen by 9,363 firms over the 1998 -2007 period. The first table regroups 5 specifications. The first column represents the baseline specification whereas the remaining estimates confirm the findings. Results provide support for the key arguments as city-sector complexity index is a substantial factor explaining the inflow of offshore investment in China. In particular, an increase by 1 percent of sector complexity index increases foreign investment to about 10.4 percent[10] . That is, sectors benefiting from exclusive and diverse knowledge tend to attract more foreign firms. One major explanation could be the presence of spillovers and market interactions within sector. If a sector is able to connect the knowledge acquired by each

[10]Odd ratio in percentage : 100(exp(0.0994-)1)

firm this improves the overall productivity of the sector.

Table 2: Conditional logit for FDI location choice : city level

	Chosen city (1)	Chosen city (2)	Chosen city (3)	Chosen city (4)	Chosen city (5)
complexity, city-sector	.0994**	.0996**	.0987**	.1002**	.0976**
	(0.011)	(0.011)	(0.012)	(0.011)	(0.013)
ln supply access	.6808***	.6806***	.6805***	.6806***	.6796***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln market access domestic	.0291	.0287	.0319	.0285	.027
	(0.153)	(0.159)	(0.119)	(0.163)	(0.185)
ln market access foreign	5.476***	5.443***	5.044***	5.47***	5.572***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln GDP per capita	-.0749	-.0764	-.0778*	-.1076*	-.1024**
	(0.109)	(0.104)	(0.097)	(0.069)	(0.034)
ln population	.0281	.0278	.0263	-.0114	.0374
	(0.513)	(0.517)	(0.541)	(0.843)	(0.386)
ln employement	-.149***	-.1487***	-.171***	-.1521***	-.1616***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Sectoral network	.0413***	.0413***	.0412***	.0414***	.0413***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln export share, city		.068			
		(0.694)			
Special economic zone			.0654		
			(0.151)		
ln fixed asset				.0425	
				(0.334)	
Nat. ressource over GDP					-.0076**
					(0.011)
Pseudo R^2	0.240	0.240	0.240	0.241	0.240
province fixed effect	Yes	Yes	Yes	Yes	Yes
Investment x cities	424,072	424,072	424,072	422,406	422,869

p-values in parentheses
* $p < .1$, ** $p < .05$, *** $p < .01$

Turning to the agglomeration variables, the results are similar than previous analyses. Table two confirms the role of the upstream supplier and market size. Agglomeration coefficients are found positive and can be interpreted as elasticities[11] . The ease of access

[11]Head and Ries(1995) : if the location choices are sufficiently high then estimations can be view as elasticities

to suppliers allows a city to attract more foreign firms. For instance, a larger number of local suppliers of intermediate inputs in the host city improve the city's attractiveness. Precisely, an increase by 10 percent supply access is associated with 7 percent new foreign firms entry. Proximity to market is also significant at 1 percent for foreign market but turn to be insignificant for domestic market. The remaining city level variables (population, employment) enter in the expected way, as does the proxy for labor cost (GDP per capital), which is significantly negative. Result for sectorial network is also in line with the literature by appearing extremely significant and positive. Newly invested firms serve markets where other foreign firms are established since previous years.

The last columns include control variables to verify if results are still robust. Including the city's export share slightly increase the impact of sectorial complexity. Chinese government has been set up trade policies since 1979 in order to promote industrial activities, innovations and exportations. Chinese authorities entitle targeted cities to implement tax incentives and foster administrative procedures. These policies confine FDI in special economic zone (SEZ). The SEZ dummy is constructed following Wang and Wei 2010[12] and the odd ratio of investing in theses cities increase the probability by 1.06 (exp(0.65)) compare to other cities. Columns 4 tests the robustness of the results by including fixed asset variable. The last column accounts for low-intrinsic values of complexity by controlling for primary sector over GDP. Including this variable does not impact the main result while coefficient appears negative and insignificant.

[12]Wang and Wei (2010), What accounts for the rising sophistication of China's export? 67 cities are listed by incentive type: SEZ, Economic and technological development area, Hi-technology industry development area and export processing zone

3.2.2. Sector intensity

Recent findings highlighted the importance to take into account the heterogeneity between sectors (Wen (2004), He et al (2008)). Indeed industries differ according to technological content. Specifically, the most advanced industries are probably more sensitive to the degree of skill embedded in a location. In contrast, less responsive industries in term of skill intensity may find more essential to hire low cost labor.

Table three reports coefficients of complexity at the city sector level for 2 digits industry. Industries are slip into two categories, top industries belong to sectors requiring exclusive and diverse capabilities whereas bottom industries need less specific capabilities. One striking observation is that there are large variations across industries with the largest effect in glass product. Theses industries are very sensitive to the level of knowledge because it is necessary to combine diverse and non-ubiquitous knowledge to perform tasks. Effects of firms response to complexity for bottom sector are little and mostly irrelevant.

Table 3: Sector intensity

	Top			Bottom		
	Alloy iron smelting	Railroad transport equipment	Glass product	Woolen textiles	Printing ink and mastics	Soft drink
	(1)	(2)	(3)	(4)	(5)	(6)
complexity, city-sector	.3062*	.3175***	.6177*	.0223	.1011	.2932
	(0.075)	(0.004)	(0.095)	(0.930)	(0.813)	(0.213)
Pseudo R^2	0.067	0.070	0.108	0.087	0.118	0.072
province fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Investment x cities	19,170	15,422	5,395	12,987	3,333	21,971

p-values in parentheses

* $p < .1$, ** $p < .05$, *** $p < .01$

3.3. Robustness check

Further robustness tests are conducted in table 4. Column 1 and 2 check for the city specificities whereas columns 3 to 7 account for firm characteristics.

One possible test when focusing on location choice is to validate the independence of irrelevant alternative (IIA) assumption[13] . This examination helps to evaluate if firms still choose the same location when excluding choices (i.e cities). If the test is concluding, then eliminating some of unchosen alternative does not affect the selection of the location as the best option. Inspection is done in column 1 and 2. Figure 3 clearly shows that foreign investments in China are unevenly spread. More precisely, supercities (Beijing, Tianjin, Shanghai and Chongqing) benefit to political flexibility and tend to be more open. By excluding these 4 cities from the sample, any change occurs for the variable of interest. Second estimation excludes cities with less than 8 entries while this change does not alter the main results. The independence of irrelevant alternative is validated and the results appear to be unbiased.

The second wave of test focuses on firm characteristics. Third estimatation keeps out non-manufacturing activities, it turns out that results are similar to what table 2 displays. Columns 4 and 5 investigate if outliers bias the results. To tackle this issue, a first estimate concentrates on the size of the firm by excluding biggest employers –more than fifty percent in the sample. Then, firms producing more than seventy-five percent for export purpose are eliminated. China is known for its export oriented strategy and foreign firms may be at the tail of the production, therefore exporting complex goods are only statistically artificial. Neither of these changes alter the results.

The last two columns aim to check the results of Xu and Lu (2009). They pointed out the importance of taking into account the origin of FDI. Column 6 divides sectorial

[13]Head and Ries (1995), Train(2003), Guimaraes (2004)

Table 4: Robustness checks

	No supercities (1)	Less than 8 entries (2)	No non-manufacturing (3)	No biggest employer (4)	No export oriented (5)	HTM vs others (6)	HTM (7)
complexity, city-sector	.1038**	.0799*	.1884*	.1041**	.0875*	.1018***	.1053*
	(0.012)	(0.092)	(0.057)	(0.011)	(0.066)	(0.009)	(0.065)
ln supply access	.6769***	.6476***	.6673***	.6807***	.6732***	.6976***	.7263***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln market access	.0213	.015	.1135***	.0628***	.0722***	.0592***	.0425
	(0.307)	(0.536)	(0.003)	(0.004)	(0.005)	(0.004)	(0.132)
ln market access foreign	4.975***	4.995***	6.414***	5.254***	5.053***	3.883***	4.756***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ln GDP per capita	-.005	-.0918	-.2759**	-.1297**	-.2855***	-.1156*	-.0077
	(0.935)	(0.189)	(0.013)	(0.034)	(0.000)	(0.050)	(0.922)
ln population	.0764	-.0131	-.0832	-.0526	-.0432	-.0783	-.0507
	(0.201)	(0.849)	(0.436)	(0.379)	(0.555)	(0.173)	(0.508)
ln employement	-.1905***	-.1161**	-.023	-.1653***	-.0826	-.1252***	-.2152***
	(0.000)	(0.010)	(0.772)	(0.000)	(0.112)	(0.002)	(0.000)
ln fixed asset	-.021	.0185	.0624	.1145**	.0093	.0495	.0203
	(0.648)	(0.730)	(0.416)	(0.013)	(0.864)	(0.260)	(0.739)
Sectoral network	.041***	.0398***	.0329***	.0412***	.0402***		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
Sectoral network HTM						.0648***	.0597***
						(0.000)	(0.000)
Sectoral network others						.0993***	
						(0.000)	
Pseudo R^2	0.241	0.168	0.230	0.256	0.233	0.251	0.267
province fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Investment x cities	377,607	142,208	169,755	400,414	264,361	422,406	211,661

p-values in parentheses

* $p < .1$, ** $p < .05$, *** $p < .01$

network into two categories, HTM and the remaining foreign investors[14]. The odd ratio for non Chinese foreign firms is 1.104 (exp(0.099) against 1.035 (exp(0.099-0.064) for HTM. Foreign firms are more sensitive to sectorial networks than their Chinese counterpart (HTM). It confirms recent observations, Hong-Kong, Taiwan and Macao investors are ethnically similar than mainland Chinese and share the same language. They have a better knowledge of the Chinese market and can account more on domestic firms than others foreign companies. The results are almost unchanged regarding the city-sector complexity. Column 7 considers only a subsample of investor –HTM. The results seem robust to these exclusion and are not driven by Chinese investors from Hong-Kong, Taiwan and Macao.

[14]The database contains 4,853 non HTM investors and 4,510 HTM investors.

4. CONCLUSION

A unique dataset, containing roughly 9,363 firms up to 174 location choices, is constructed to examine the determinants of foreign firm's entry in Chinese city over the years 1998 to 2007. The main originality of this work is to develop an index of complexity that rely on what a country is producing to induce the amount of knowledge embedded in a location. The results suggest that the access of exclusive and diverse capabilities is the key determinant of FDI inflows. The findings show that increasing city-sector complexity by 1 percent is associated with 10 percent increase in foreign investment. One possible reason is foreign firms are sensitive to the market interaction and potential spillovers within a sector.

The conditional logit estimate provides also strong support for the existence of agglomeration economies. Foreign firms that are not from Hong-Kong, Macao and Taiwan (HTM) are more likely to invest in city where many companies of the same industry have already invested. Chinese foreign counterparts (HTM) can account on the domestic firms to cooperate because they share the same language, culture and have a better acquaintance of the market. Evidence seems robust to an array of test and support the main results. Further works could be to decompose trade flow into ordinary trade and processing trade to evaluate if complexity is still substantial to entice foreign direct investment.

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5. TABLES AND FIGURES

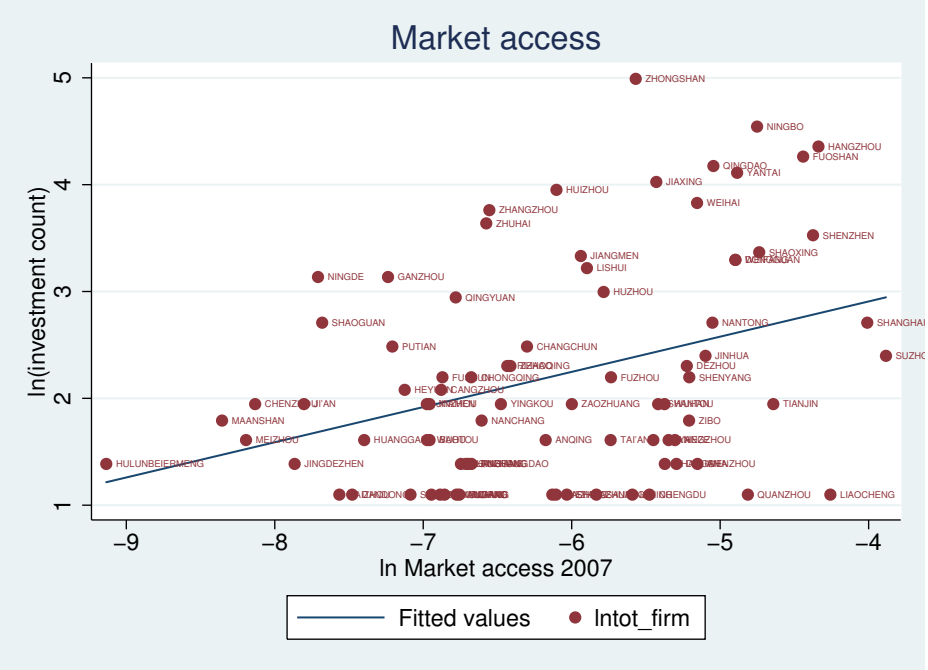

Figure 5: Market

Table 5: Industries with the highest net entry of Foreign Investment Entreprises

Year	City	Industry name	Number of entry
2004	QUANZHOU	Textiles productions	29
2003	QUANZHOU	Textiles productions	26
2004	NINGBO	Hemp textiles	22
2006	NINGBO	Metal products	21
2004	QUANZHOU	Knitted and crocheted fabrics and articles	21
2007	ZHANGZHOU	Textiles productions	20
2004	NANTONG	Textiles productions	18
2007	ZHONGSHAN	Textiles productions	18
2004	NINGBO	Railroad transport equipment	18
2004	SUZHOU	Generators	18

Table 6: Industries with the highest industry complexity level

Year	City	Industry name	Complexity sector
2004	DEZHOU	Metalworking machinery	1.93
2002	FUOSHAN	Chemical pesticides	1.85
2005	CHONGQING	Products of wood, bamboo, cane, palm, straw	1.80
2005	PANJIN	Glass and glass products	1.79
1999	CHANGZHOU	Agriculture, forestry, animal husbandry and fishing machinery	1.74
2004	SUZHOU	Chemical pesticides	1.73
2005	HANGZHOU	Chemical products for daily use	1.73
2005	ZAOZHUANG	Cement, lime and plaster	1.71
1999	JILIN	Paints, varnishes and similar coatings, printing ink and mastics	1.70
2004	JINAN	Pump, valve, compressor and alike machinery manufacturing	1.70

Table 7: Summary statistics

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**
year	2003.723	2.681	1998	2007	9363
employment	226.902	393.985	0	7662	9362
output	63922.767	406586.923	3	22149066	9363
export	23680.797	301120.415	0	22114675	9363
capital	28411.136	163375.443	1	13300000	9363
HTM capital	8128.126	35599.233	0	1371934	9363
Foreign capital	14171.707	94077.771	0	6650000	9363
complexity, city-sector	-0.392	1.029	-2.899	1.931	6382
sa	0.01	0.017	0.000	0.297	9363
ma	0.009	0.011	0.000	0.124	9363
ma fo	27.991	0.914	26.513	30.49	9222
ln gdp per capita	10.462	0.673	7.645	12.677	9299
ln pop	5.028	0.904	3.195	7.177	9317
ln employment	3.514	1.14	0.476	6.546	9317
ln fix asset	14.638	1.35	10.412	17.592	9300
Nat. resource over GDP	4.677	5.776	0.1	60.47	9294
Sectoral network	7.673	10.847	0	92	9363